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THESIS

APPLICATION OF SMART CARDS IN THE COLOMBIAN NAVY PERSONNEL MANAGEMENT SYSTEM

by

Fabio A. Cuello Cogan

June 1999

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

| | | | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------------------|-----------------------------------------------------|--|
| 1. AGENCY USE (Leave Blank) | | 2. REPORT DATE June 1999 | 3. REPORT TYPE AND DATES COVERED Master's Thesis | |
| 4. TITLE AND SUBTITLE Application of Smart Cards in the Colombian Navy Personnel Management System | | | 5. FUNDING NUMBERS | |
| 6. AUTHOR(S) Fabio A. Cuello Cogan | | | | |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000 | | | 8. PERFORMING ORGANIZATION REPORT NUMBER | |
| 9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) | | | 10. SPONSORING / MONITORING AGENCY REPORT NUMBER | |
| 11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the United States Government. | | | | |
| 12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited. | | | 12b. DISTRIBUTION CODE | |
| This study examines the potential application of smart cards in personnel resource management in the Colombian Navy. It reviews the organizational and procedural efficiency of the personnel management system and suggests ways in which smart cards might improve its efficiency. Smart card capabilities in improving the personnel management are described. Recommendations are offered for the implementation of a demonstration prototype. A plan for implementing a smart card system throughout the Colombian Navy is suggested. | | | | |
| 14. SUBJECT TERMS Columbia, Smart Card Technology, Personnel Resource Management | | | 15. NUMBER OF PAGES | |
| | | | 16. PRICE CODE | |
| 17. SECURITY CLASSIFICATION OF REPORT Unclassified | 18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified | 19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified | 20. LIMITATION OF ABSTRACT Unlimited | |

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18

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**APPLICATION OF SMART CARDS IN THE COLOMBIAN NAVY PERSONNEL
MANAGEMENT SYSTEM**

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Submitted in partial fulfillment of the
requirements for the degree of

**MASTER OF SCIENCE IN INTERNATIONAL RESOURCE PLANNING AND
MANAGEMENT**

from the

NAVAL POSTGRADUATE SCHOOL
June 1999

ABSTRACT

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This study examines the potential application of smart cards in personnel resource management in the Colombian Navy. It reviews the organizational and procedural efficiency of the personnel management system and suggests ways in which smart cards might improve its efficiency. Smart card capabilities in improving the personnel management are described. Recommendations are offered for the implementation of a demonstration prototype. A plan for implementing a smart card system throughout the Colombian Navy is suggested.

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I. INTRODUCTION

We have finally arrived at the long awaited year 2000, with whatever dreams and predictions of the technological state in which we would find ourselves at this time. Some of these predictions have been surpassed in the field of communications, especially in the United States and also in Colombia. However realistic we are about many fields, the year 2000 and the 21st century is almost surprising to us in what would be considered, whether consciously or subconsciously, our state of technology.

At the same time, the Military Forces and the National Navy in Colombia have in such a short time undergone important changes in their structure and budget. They are responsible for this occurring without these changes affecting their operational capability. The subversive situation in Colombia has entered into a state of no return for better or worse. If the results are the product of a solid position of the democratically constituted government, the more likely that the Military Forces will find themselves in a situation similar to the one in which they are now. No doubt, however, a decrease in the budget, and therefore of personnel, will more likely be the result at the end of the conflict. Considering that a budget will be necessary for the reconstruction and impetus for the development of the country, the need to dedicate many resources to the Military Forces will surely face more and more opposition.

This imminent situation demands that the Military Forces, which at the same time as facing this first priority and collaborating to reestablish public order in the country, be prepared to fulfill its natural strategic mission in an atmosphere of more budgetary restrictions. The only way to confront this increase in restrictions is to take advantage of Information Technology (IT) solutions having the same or better operational and administrative results with fewer resources.

By keeping pace with technology, looking for cost-effectiveness solutions, and great technological output that allows for a highly technological and practical organization, we will help in obtaining results with a minimal output of resources in budget and personnel. The Light Frigate ships class ARC "Almirante Padilla" and the Colombian Naval Academy would be candidates to initiate the administrative-operative automation of personnel in the National Navy. Since these units are at this moment state-of-the-art technology in the National Navy, they possess a larger amount of basics resource to initiate the project at a smaller possible cost.

This study provides the necessary information required for implementing a Smart Card-based Personnel Management System which will improve the health, security and other personnel and welfare services for every member in the Colombian Navy and serve as an example for the other Armed Forces. High standards in personnel management will also serve as an example of a leading position of the Navy in information technology and other organizations in the country.

A. BACKGROUND

At this moment, the administrative burden of the more experienced members of an operative unit, the Commanding Officer (CO) and the Executive Officer (XO), is so great that their capacity for generating preventive or offensive operations is minimal. Dedicating operations to a mainly defensive or responsive position to orders also results from the need to address contingencies. This administrative load must be reduced for the sake of providing more time for operative planning that will translate into better results. IT is an answer to the need for reducing the administrative burden. All processes that need one or more individuals dedicated to inputting data in a typewriter or even in a computer must be updated. How many times during the year or months must the same

names and administrative data be input into our systems because of the lack of systems that can do it automatically? How many times must the same data be entered in order to process administrative, monthly, quarterly, semi-annual, or annual information; or to update administrative and operative watchbills whenever a member changes? How much time does the XO dedicate to the continuous update of his attack watchbills? How many updates of Addresses, telephones, unit, employees are necessary for any administrative procedure? And even worse, what if this information has to be sent in a document from one unit to another or must go into a document that has to go through the chain of command inside and outside the unit. This simple updating of information increases the administrative burden on the XO and CO. This time can be better spent on other levels of concern, or must wait until the next periodical report the unit needs to send. This not only results in a direct burden for the CO and XO but also created an inefficient Navy personnel management system.

B. RESEARCH OBJECTIVE

The purpose of this thesis is to show the benefits of the Smart Card technology, and the way this technology can be applied to the administrative-operative management of personnel in the Navy. In order to facilitate the understanding of the new system, and the benefits of its application, an initial model is developed in an ideal environment in one of the most modern units of the Colombian navy; a light frigate class ARC "Almirante Padilla." The idea is to implement a relatively cheap IT solution to personnel problems in the Colombian Navy. By expending few resources in a small environment of less than 100 men, the benefits of the system can be examined, and this test will become the basis for expanding the system to other units, and shortly to the whole Navy. At the same time, this allows for a progressive change in maintaining the organization's general equilibrium, since affects only one part of the organization at a time. [Ref. 1:p. 287]

C. RESEARCH QUESTIONS

The primary research question is: How can Smart Cards be used to enhance personnel management in the Colombian Navy? The subsidiary questions are:

1. How is personnel management conducted in the Colombian Navy today and what problems are evident?
2. What are smart cards? What advantages and/or limitations are associated with them?
3. What opportunities exist for using smart cards for personnel management? How should such opportunities be exploited?
4. How can smart card use be extended to other process within the Colombian Navy? Can smart cards be adopted for personnel management in other services?

D. SCOPE, LIMITATIONS AND ASSUMPTIONS

This thesis focuses on finding the solutions for an inefficiency problem in the different phases of the personnel management process. In order to analyze and propose a solution for those inefficiencies, the personnel management theories have been reviewed to correct the organizational deficiencies. Also, the Smart Card capabilities and benefits for correcting the time spent on countless digital inputs of data, saving paperwork and avoiding slow mail data transfers are studied.

Taking advantage of several matters studied during the Resource Planning & Management for the International Defense Curriculum may help to find an integral solution to improve Personnel Management in the Colombian Navy. Beginning with a specific model onboard a Light Frigate Ship complete with its own personnel management problems that affect the overall management in the Navy, a solution will be looked at that may help find an overall solution as well.

E. METHODOLOGY

In order to answer the research questions, the first action was to distribute the pertinent topics to different chapters of the thesis. At the same time a comprehensive review of bibliography available on those topics was conducted at the Naval Postgraduate School (NPS) library, and on the Internet. The bibliography found on the Internet was requested at the NPS library as Inter Library Loans, and received on time to conduct the research.

By electronic mail several requests for information were placed about the smart card (SC) technology. As a result I was invited to visit the Navy Smart Card program office and the Navy/GSA Smart Card Technology Center in Washington.

The invitation was accepted and those places were visited. Interviews were conducted and presentations listened to from various personnel involved in the implementation process in the Navy and in the GSA, as well as discussing experiences, future steps for their programs, and also sharing my ideas for the thesis to found out if they were suitable.

A visit to a private company was conducted as well as talking with the person with the most experience in the company about the military environment. A presentation was attending on recent projects and capabilities. Later, a draft of the implementation plan was sent by e-mail for suitability analysis to this company to verify if the smart card application in the plan was possible with the existing technology.

A new bibliography was requested and received which had all the bibliographies available in the U.S. about the smart card, and the support of government agencies and private companies to get the most updated and

accurate information about the smart card's technology applications and experiences.

The knowledge and data about the Personnel Management System is the product of my experience of 25 years in the Navy as a user and as a part of the system. The specific technical data was acquired by e-mail and phone with the different offices of the navy and with personnel of the Light frigate ARC "Almirante Padilla" where I served as Operation Department Head. Also, I have the experience as Executive Officer of the Light Frigate ARC "Independiente," a ship of the same class which facilitates the development of the prototype.

For the analysis of the current personnel management system, the way reports and data are updated are represented in attributed diagrams. This provides a way to visualize the process flows through a graphic representation. The current personnel management system is diagnosed to identify pathologies of flows in the process. From this diagnosis the inefficiencies in the current personnel management system are used to identify opportunities to redesign its process in an attempt to effect quantum gains in performance.

F. ORGANIZATION OF STUDY

This study is organized into five chapters, beginning with this introduction. Chapter II describes the latest advances in smart card technology based on what may prove useful in the Colombian Navy. It is oriented towards smart card application suitable for a Personnel Management Automated System, rather than going in depth about the technical electronic details. Each application is explained in detail for later analysis of which capabilities can be applied to the design of the system. Chapter III discusses the current situation of the Colombian Navy Personnel Management System. It does not criticize the politics or personnel performance but looks at the organizational and procedural efficiency of the system and analyzes scientifically the organization to suggest

the best way to improve said organization. Chapter IV discusses the possibilities and benefits of the implementation of smart card (SC) based systems for personnel management in general, and specifically the application in the Colombian Navy. It describes how some of the SC capabilities can be used in applications that improve the efficiency of the Personnel Management System. The implementation of Smart Card Based Systems for Personnel Management is suggested in a step by step basis in order to be used as a guide in the case that such a program is authorized to be implemented. Chapter V presents conclusions and recommendations about the personnel management system and the application of Smart Cards for improvements. It also includes suggestions for future research.

II. SMART CARD TECHNOLOGY AND APPLICATIONS

A. INTRODUCTION

Since there is already a Naval Postgraduate School (NPS) thesis from 1994 [Ref. 2] that technically describes what a Smart Card is and how it works, this thesis does not discuss those technical details in depth, but it provides an update by describing the latest advances in this technology based on what has proven useful for the Colombian Navy. This technological update provides a backdrop for successive analysis and redesign of the personnel management system. The main emphasis is on applications, since this thesis is more oriented towards System Management issues than technical matters. The focus of this chapter is more strategic than technical.

Since the time that Smart Cards were developed, they have improved and are more popular. In 1997, there were over 1.3 billion chip cards in circulation, 75% of which were used throughout Europe. It is expected that by the year 2002, 3.2 billion chip cards will be used around the world with 46% being used in Europe, 34% in Asia, 10% in the United States and 10% in the rest of the world. [Ref. 3]

B. SMART CARDS UPDATE

A Smart card is a plastic card the size of a credit card embedded with an integrated circuit chip. This integrated circuit chip could be either a microprocessor and a memory chip or only a memory chip with non-programmable logic. The microprocessor card can add, delete, and otherwise manipulate information on the card, while a memory-chip card can only undertake a pre-defined operation. Smart cards, unlike magnetic stripe cards, can carry all necessary functions and information on the card. Therefore, they do not require access to remote databases at the time of the operation. [Ref. 4] The chip stores information while protecting it from unauthorized access. It is the

safest system in use today. [Ref. 5] With their microprocessors and computational power, smart cards are virtually impossible to duplicate, unlike magnetic stripe or bar code cards. [Ref. 6]

1. Types of Smart Cards

Today, there are three types of smart cards; all of which are evolving rapidly into new markets and applications.

a. *Integrated Circuit Microprocessor Cards*

Also referred to as "chip cards," they have more memory storage and security of data than a magnetic stripe card, and can process data on the card. The current generation of chip cards has an eight-bit processor, 16KB read-only memory, and 512 bytes of random-access memory. This gives them the equivalent processing power of the original IBM-XT computer, [Ref. 7] although with a little less memory capacity.

These cards are used for different applications, especially those that have cryptography built in, which requires manipulation of large numbers, and have been the main platform for cards that hold a secure digital identity. These cards are used for money storage information, money equivalent information, identification for secure access to a network, and identification that secures cellular phones from fraud.

b. *Integrated Circuit Memory Cards*

IC memory cards can hold up to 1-4 KB of data, but have no processor on the card with which to manipulate data. Thus, they are dependent on the card readers, also known as card-accepting devices, for their processing and are suitable for uses when the card performs a fixed operation.

Memory cards represent the bulk of the 600 million smart cards sold last year primarily for pre-paid, disposable-card applications like pre-paid phone cards. Memory cards are popular as high-security alternatives to magnetic stripe cards.

c. *Optical Memory Cards*

Optical memory cards look like a card with a piece of a CD glued on top - which is basically what they are. Optical memory cards can store up to 4 MB of data, but once written, the data cannot be changed or removed. Thus, this type of card is ideal for record keeping, such as medical files, driving records, or travel histories. Today, these cards have no processor in them, although this will be available in the near future. While the cards are comparable in price to chip cards, the card readers use non-standard protocols and are expensive.

2. Access to Data

It is also important to know that the information can be accessed in several ways from the Smart Card.

a. *Read Only*

Some information contained in a smart card can only be read only. The information is fixed like a book, where information cannot be added, modified, or erased. This information contains a unique number for each card, the number of units in the card, and an indication of whom manufactured it. This information can be easily read, but not modified in any way.

b. *Add only*

Some information in a smart card can only be added to, but not erased. Information contained on the card cannot be modified or erased; and new information can only be added while there is still space available on the card. Added information can also be read.

c. *Modify or Erase*

In this instance, information can be modified or erased like writing on a black board. Information can only be added when there is still space available on the card.

d. *No Access*

In order to provide greater security, some information on a smart card can never be accessed. This information is encrypted in a secure area of memory so that it cannot be tampered with for security reasons and includes data that never changes like full name, blood type, military code, eye color, etc.

3. *Special Kinds of Cards*

a. *Hybrid Card*

The smart card may also contain one or more other items such as magnetic stripe, bar code, digitized photo, and printed information for storing information about the cardholder. These kinds of cards are called hybrid cards.

b. *Multi-Application Card*

This is a card that can be used for a wide range of applications, and eliminates the need to carry a pocketful of single purpose cards. The idea is that a card holder will only carry one card that allows him or her to use it for several purposes, such as [Ref. 8]:

| | |
|--------------------------------|--------------------------------------------------------|
| Security | Property accountability |
| Identification authentication | E-mail and document processing |
| Physical building access | Emergency medical/dental and/or healthcare information |
| Travel | Event tracking |
| Internet purchasing | Mobile Communications |
| Networking and database access | Electronic Remote Payment |

| | |
|-------------------------------|------------------------|
| Computer system access | Loyalty Cards |
| Payphones | Pay TV |
| Point of services terminals | Electronic commerce |
| Parking | Financial transactions |
| Prepayment Cards | Education |
| Transportation/Ticket Vending | |

A Multi-application Card is what is necessary in order to implement a system in the Navy because of the multiple needs for transferring information from each individual to the personnel system.

The smart card also differs in the way in which it interacts with terminal equipment be it with and without contact:

c. *Contact Cards*

Are smart cards activated by being inserted into a smart card reader, which presses contacts against the contact pads of the smart card module. These cards must be precisely positioned in the terminal and their contacts must be free from non-conducting contaminants such as oil or rust. The card reader generates the power that runs the card.

d. *Contactless Cards*

Contactless cards need not necessarily be inserted into a card reader, since they interact with it via electromagnetic coupling, working at a distance of up to one meter. There are actually two types of contactless cards – passive and active. The passive card derives its power from a frequency generated by the reader. The active card actually has a battery imbedded within it.

C. SMART CARD'S CAPABILITIES AND APPLICATIONS

Nowadays Smart Cards can be used for many different tasks. The latest advance in Smart card technology is the multi-application SC. This section describes those applications in order to see how they can be applied to our personnel management situation. Though described application by application, the real strength of this modern SC is the possibility of having most of these capabilities on the same card at the same time.

1. Common Access ID

SC can be used as an ID card with the possibility of controlling identification and to which level of access the SC owner can be allowed. SC security features include a certificate based digital signature with encryption process for securing building access, workstations, internal network databases, secure Internet access and authorizations, secure e-mail and communications, secure document processing and other related administrative functions. It ensures that sensitive data remains safe and secure wherever it may be. Identification authentication can be performed through the use of biometrics. It is an automated process used to verify an individual's identity based on distinguishing physical characteristics, such as hand geometry or fingerprint.

2. Visitor Control

Works in conjunction with Physical Access to manage and control facility visitation. Creates and manages databases of visitors, temporary cards, card issuers, and visitor recipients.

3. Issuance or Property Tracking

Provides enhanced accountability and control over equipment, tool and weapon issuance to authorized individuals. Accounts for outgoing and incoming property and equipment with ease and reliability. Issue property passes electronically, and tracks an item to an individual instantly.

4. E-purse

This application was designed to establish trust and confidence in electronic commerce by guaranteeing the security and privacy of each transaction, offering the advantage of cash all with the convenience and security of a card. What is important is the capability of the smart card to carry “virtual money.” Fast transactions can be made with excellent control over balances and the possibility of being used for several functions. It can function as a meal card, make purchases in the cafeteria, in the bookstore on campus, or can be used at any machine with a SC reader. It will not be necessary to carry real money around while at work and or have to search for change, or have to wait for it. It can also be used at official fuel pumps for better control of official vehicles gas expenditures.

5. Event Ticketing

Registration and coordination of general events can be done where the organization is committed. This is made possible with the general tracking application of smart cards. Both event organizers and attendees can take advantage of this convenience. Attendance tracking is made simpler and more accurate with a minimum number of people involved for control.

6. Card Management Software

There are companies that provide smart card solutions tailored to comprehensive card management systems, enabling system administrators to personalize, encode, print, update, issue, hot-list, and track individual smart cards quickly and easily. These systems can fulfill the needs of many organizations in automation matters.

7. Medical/Dental

Smart card technology in the medical field makes it more convenient for the patient and doctor, as well as reducing paper work and administrative costs. This application provides instant access to vital medical data and eliminates the errors of inaccurately transcribed data in rush or emergency situations. Storing immunization data on the SC ensures that up-to-date information is immediately available for vaccination appointments, physicals and personnel deployment readiness checks. The card can be loaded with an automated documentation system that allows dental service providers to read and record accurate examination and treatment information. The exam can actually be recorded as it occurs, and the treatment can be updated just as quickly. In both cases, providers are able to quickly register patients, document medical status, interface with central medical databases, and generate administrative reports. This system is more efficient and does not compromise an individual's confidentiality and privacy.

8. Biometrics

Smart cards can use an automated process to verify an individual's identity based on distinguishing physical characteristics, such as hand or face geometry, voice or fingerprints. The information can be transferred to the SC, and the SC can be used to pass through an optical turnstile, [Ref. 6] which is an advanced building security device available today. This biometrics function can be implemented for any ID need as described earlier.

9. Financial Transactions

The smart card can be used for financial bank transactions. It offers superior security to both banks and consumers than a strip card. Furthermore, microchip technology will enable financial institutions to further define and tailor banking services to better serve their customers with services such as monthly assignment payment or deposits for covering travel expenses.

10. Personnel Locator

This is a client/server application that produces a real-time database of dispersed employees and personnel. It provides instant tracking of individuals in one location or nationwide. Records and tracks qualifications, skills, or other human resource parameters.

D. SMART CARD APPLICATION FORECAST

When an organization analyzes the possibility of implementing a new technology, one of the main concerns is that technology's future. Smart Cards seems to have an assured future because of the seemingly unlimited innovative ideas and applications that the technology offers, especially as processing and memory capabilities increase. We can even now say that smart cards are a new technology, which has for the most part developed during the past 18 months, and are now a reality. The limit of SC applications depends more on human imagination than the card's capabilities. All projections for the next decade show that the use of smart cards is going to increase significantly.

An estimate is provided by the Motorola Company as a vision of the future for the applications of Smart Cards [Ref. 9] in the following chart.

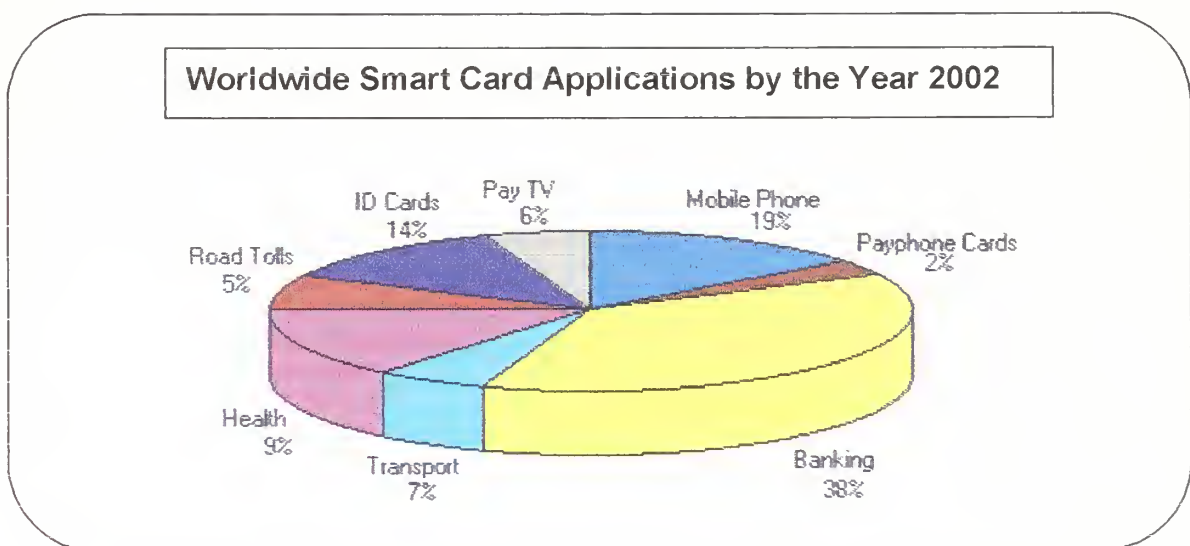


Figure 1. Forecast of the Future of Smart Card Applications.

This estimate, and other concepts in the SC bibliography, shows that smart card technology is here to stay and more applications, more markets and less cost will provide widespread use of SC technology throughout the world.

III. OVERVIEW OF THE COLOMBIAN NAVY PERSONNEL MANAGEMENT SYSTEM

A. CURRENT SITUATION

The current Personnel Management System in the Colombian Navy accomplishes the mission for the Navy, but much of the burden is distributed to members of the organization in different sections rather than in specific personnel offices. Many procedures are accomplished by different units, which have to report periodically to the regional office, and all the regional offices report to Main Personnel Office at Navy Headquarters. Inter-unit personnel communications are sent by messenger when in the same city and by mail when in a different city. In this case, personnel politics are not being discussed. Rather, personnel procedures that are routine to every unit of the Colombian Navy are seen as normal but burdensome due to the lack of IT among the units.

On board Colombian ships, Personnel Departments do not exist. This function was developed by the Master-at-Arms (MA) which is the senior enlisted member onboard. However, sometimes an E-1 needs to be assigned to the job, when only this person knows how to operate a PC, since most of the periodical reports are done by computer locally. The general internal personnel planning and execution is done by the XO and the CO conducts the external formalities for personnel problems or requirements with ever increasing, time-consuming paperwork. The MA types and organizes all the correspondence coming into and from the CO office and is responsible for all the personnel records and documents onboard as well.

Periodically each ship has to send reports with personnel information. Each report is done by the MA, printed, shown to the XO, corrected and given to the CO for his signature. This procedure can go through several iterations if any correction is necessitated by the XO and/or CO. The more experienced the MA,

the fewer iterations needed. After that, the reports are sent to the Base Personnel Office (BPO) by messenger when the ship is in port and by official mail, if available, when not in port. The base personnel office sends the reports to the Navy Personnel Direction (NPD) office at Navy Headquarters by official mail, after modifying its own records with the new information.

The latter information is used as a baseline for the existing process in order to implement the process redesign strategy. Each communication explained above is represented by an arrow in the diagram in Figure 2. Arrows from left to right depict the normal flow of work through the process, whereas arrows in the opposite direction signify feedback loops through which process activities must be repeated to address rework. In many cases, a particular task chain must be repeated until quality meets the required threshold.

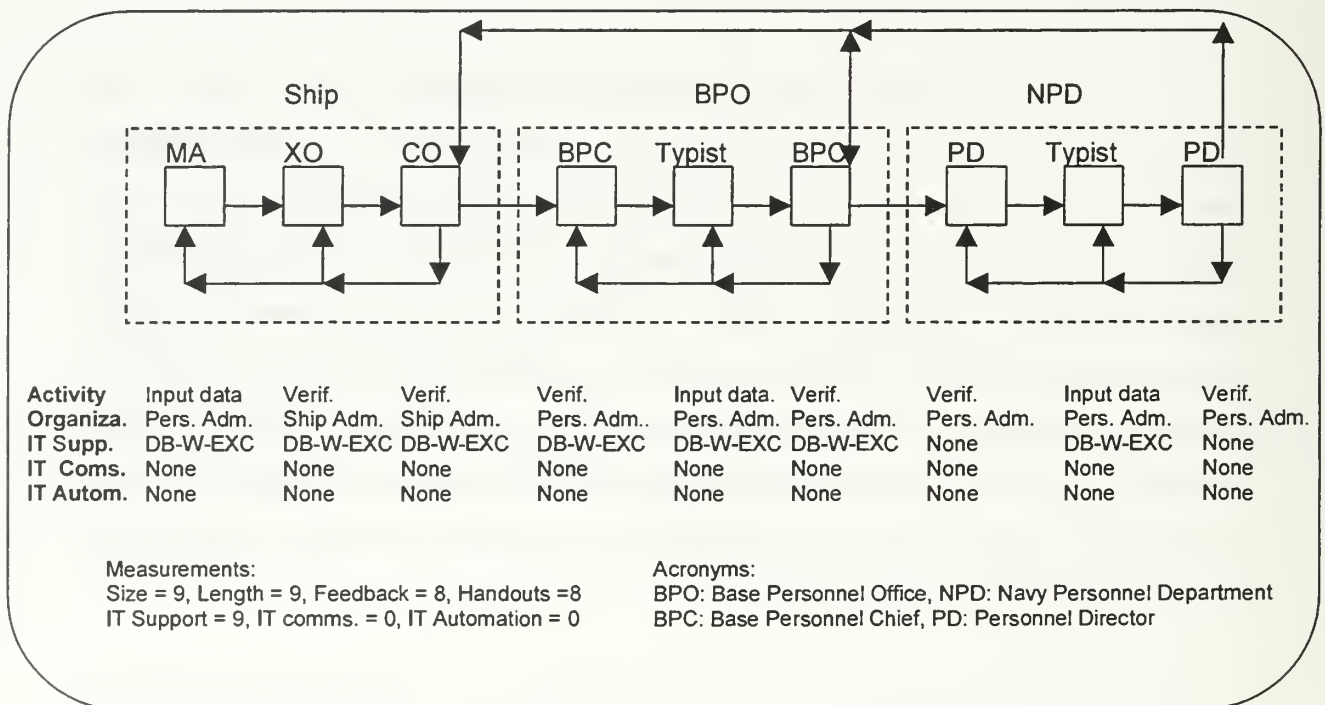


Figure 2. Simplified A-Digraph of the Personnel Management System in the Colombian Navy. For Periodical Reports and Database Information Update.

In Figure 2 an attributed directed digraph (A-digraph) representation is used for showing the Baseline Personnel Process mainly in periodical reports and in database information updates. However, it is almost the same for every personnel process in personnel decision-making onboard a LF ship or any ship in the Colombian Navy and its chain of command up to Navy Headquarters Personnel Offices. For land units, the process is slightly different, as a personnel office replaces the MA node.

This schema indicates that the process in the baseline system is comprised of three groups of three tasks. These are represented as process-activity nodes connected by task precedent edges. As a complement of the diagram the relevant attributes associated with the process are indicated, including role (job description, (i.e. input data and verification), organization (level in each group), processing mode (IT support), communication mode and value chain. This first diagram shows that each personnel report has to go through 9 nodes (length of the process), and requires 11 feedbacks (assuming one loop by node) with minimal IT support and automation in the process.

In this case, the main resource is time. The more efficient system would be the one that saves the most time with quality and quantity of the same output. The CO and XO can take advantage of this time to do other activities more suited to their jobs and increase output in other areas.

This is only one inefficiency in the personnel process in the Colombian Navy. There are also other inefficiencies in personnel related procedures, such as health, wardrobe, professional records, vacation accounting, and facilities' access. Each is discussed in turn, but a separate A-digraph is not developed in the interest of succinctness.

1. Health

The Clinic records in the Health installations are located at the nearest base to the ship. However, if one crew member or the unit is in another port and a health problem occurs, the crew member must be treated in this unit with no previous information of his normal health situation, his recent illnesses, immunization, allergies, or blood type available. All this information has to be told by the corpsman, or by the same patient who has no medical training. More time is spent for each patient with inaccurate information before any medical procedure can be performed.

2. Wardrobe

Any time a crew member changes units, especially when changing cities, the crew member has to wait at least one month for the written record to be mailed to the new unit in order to access his wardrobe assignment. If the person is only temporarily in another city, the wardrobe cannot be authorized because there is no information available. At the same time, the ship's command has no control over how their members spend their assignment. Even though it is a personal assignment, a ship's command wants to know how their members spend their assignment. This is especially important for members who do not always have their uniforms in good condition and use the excuse that the assignment is not enough or that there are not any clothes in the wardrobe store when the real reason is that they have expended their assignment on non important garments.

3. Facilities Access

It is not always seen as a personnel problem, but facilities access is a problem that influences personnel. Today, a new system is being implemented at Cartagena's Navy Base, the main Colombian base, based on non-contact cards as a means of identification (ID) verification. It is necessary to create a multipurpose card that will work with all systems and applications in order to

avoid having each unit develop its own system since each Navy member would then need one ID for each unit.

4. Professional Records

Each time a Navy member changes station, his professional record has to be sent by mail to the new unit. The member always arrives before the information. At the same time the information is only about his last assignment, and not a record of what has he done throughout his career, which training he completed, which special courses taken, etc. Then, the member gives all the information to the new unit which is not always exactly the same given at his last unit or what is in the main personnel records at Main Headquarters in Bogotá. The same member ends up with inconsistent data and the unit where he arrives does not have the information needed to assign him the job for which he is better trained.

5. Vacation Accounting

The system relies on the member for vacation accounting. When a member is leaving on vacation, he has to go to different offices with the paperwork. He must verify the number of vacation days available, or make a request by mail or by messenger. After the vacation is authorized, the member has to go to several offices with the signed paperwork, record it in the system and deduct the number of vacation days to be taken. A simple vacation request that normally follows a vacation plan for each unit needs a great deal of personnel paperwork and time.

B. PROCESS ANALYSIS

Based on the process, model and measurement described above, it is now necessary to diagnose the pathologies of the process in order to redesign the personnel management system. A graph-based redesign tool called "Knowledge-Based Organizational Process Redesign" (KOPeR) is used to

perform to this diagnostic step. KOPeR relies on the attributed digraph (A-digraph) information from Figure 2 to drive its diagnostic inference. A further explanation of this method can be found in Ref. 10 where each measure and definition is widely described.

Using the Web-interface version of KOPeR [Ref. 10] for analysis, the diagnosis is based on the measurements of figure 1: (e.g., Size = 9, Length = 9, Feedback = 11, IT Support = 9, IT Comms. = 0, IT Automation = 0.) Based on this input, KOPeR identifies a number of process pathologies listed in Table 1.

Measurements (e.g., size of 9) suggest the *small Personnel Management Process* suffers from the following pathologies:

Parallelism (1.0) - *sequential process*.

Handoffs fraction (2.0) - *process friction*.

Feedback fraction (0.889) - *checking & complexity*.

IT support fraction (0.778) - *IT support looks OK*.

IT communication fraction (0.0) - *inadequate IT communications*.

IT automation fraction (0.0) - *IT automation first requires substantial infrastructure in terms of support and communication*.

Table 1. Pathologies of the Process Identified by KOPeR. [Ref. 10]

Based on the pathologies above, KOPeR recommends the redesign steps listed in Table 2 be considered. Each pathology is explained in Table 3.

For redesign, we recommend you consider the following:

Delinearize process activities to increase parallelism; such activities must be **sequentially-independent** (e.g., have mutually-exclusive inputs and outputs).

Try a **case manager** or **case team** to decrease friction; be sure to include a source of expertise.

Try **empowerment** to reduce the amount of checking in the process; be sure to address **training and incentives**.

Look to **information technology** to increase support to process communications; e-mail and shared databases through local/wide area networks generally have good payoffs and workflow systems can greatly expedite process flows; be sure to address personnel **training and maintenance** of the IT.

Look to **information technology** to automate process activities, but note that substantial **IT infrastructure** is first required, particularly in terms of process support and communication; try workflow systems for support and communication, and then look to intelligent agents, which can enable many electronic commerce opportunities.

Try either **asynchronous or contemporaneous reviews** to conduct quality/feedback loops concurrently or jointly; **scheduling** becomes a concern with this redesign.

In addition to delinearization and the use of a case manager, workflow systems offer good potential for process improvement; try to avoid **paving the cowpaths** by ignoring other process pathologies, however. [Ref. 11]

Table 2. Redesign Steps Recommended by KOPeR. [Ref. 10]

The meaning of this diagnosis is given in Tables 3:

From the parallelism measurement, one or more steps have to be set in parallel in order to delinearize the process. Linearization is a time and resources consuming pathology. Delinearization involves rearranging a sequence of process activities to be performed in a more parallel or concurrent manner. Process parallelism or concurrency has positive performance effects in terms of cycle time, and often cost, as activities are performed in parallel as opposed to sequentially. This redesign transformation affects the sequence and flow of process activities, but not how or by whom they are performed.

Sequential-independent means that delinearization can significantly reduce process cycle time, particularly when high-level process activities are delinearized. However, if two process activities are sequentially-dependent, they cannot be performed concurrently; rather, they must continue to be performed in series. One test for sequential-independence is to analyze the inputs to, and outputs from, each process activity. Where the inputs to an activity, call it Step-2, are not produced by the preceding activity, call it Step-1, the two activities offer a good opportunity to be performed in parallel.

The case manager transformation involves replacing specialized employees in a process often from different functional departments with a generalist case manager who performs all process activities from start to finish. A case manager can have positive performance effects in terms of cycle time, and often cost, as a single case manager obviates the need for handoffs and inter-departmental coordination. When a case manager or case team is instituted, the personnel performing in such process roles are usually generalists—broadly skilled in a number of different jobs—and are seldom possess expertise about all required tasks and activities. The generalist worker(s) can be expected to perform well, so long as the process activities are not unusual, complex or novel. Work performance that is not customary, simple and familiar often requires more expertise than is possessed by a generalist case manager.

Table 3. Explanation of Diagnosis Given by KOPeR. [Ref. 12]

Thus, expertise is required to support the generalist in these situations. Expertise is most commonly provided through the retention of some expert personnel, who can serve as advisors or internal consultants when problems arise. With the advance of knowledge systems technology, however, much of this expertise can be captured and formalized through intelligent systems.

Empowerment involves delegating responsibility to front-line employees and authorizing the people doing process work to ensure the quality of their work. Empowerment can have positive performance effects in terms of cost and cycle time, as quality 'checking' steps can be avoided and empowered employees often produce superior work products at a lower cost. Empowerment entails some job enlargement.

As concerning training and incentives, empowerment can create a number of process improvements by authorizing decisions to be made by personnel who are directly responsible for performing process work. This can eliminate lengthy decision-making and feedback loops, and can augment process quality. However, employees who are unaccustomed to making decisions are likely to require training, in addition to having the requisite decision-making information provided. This represents a critical factor in the success of empowerment. Personnel who are newly empowered are also likely to perceive a (real) increase in their level of responsibility. This represents a key motivating factor behind the increased process quality noted above, but the personnel must also be stimulated to take-on this additional (perceived) responsibility. Monetary compensation is not necessarily required, as employer-sponsored training, expanded job title, business cards, improved office surroundings and other factors can also stimulate many people.

IT Infrastructure is particularly important to support the automation of knowledge and information work, and is generally considered to represent a necessary precondition for success. IT support of process activities such as computers, software, decision support systems, databases, word processors, etc., and communications such as e-mail, Intranets, and workflow systems, represent key infrastructural elements. A workflow system is often required to support many approaches to knowledge-work automation, particularly where work crosses agent roles and organizational boundaries. Intelligent agents require knowledge and information in digital form. Therefore these basic IT infrastructural elements are required even to begin such automation work.

Table 3. Explanation of Diagnosis Given by KOPeR (Cont.). [Ref. 12]

With regards to IT Training and Maintenance, information technology represents a very powerful enabler of process innovation. IT support of process activities and communications requires personnel training in many organizations, however. Indeed, many techno-phobic employees will find new IT threatening, and are likely to resist change. Training represents one approach to addressing such employees. Techno-phobic or not, simply inserting new IT into a (human) process cannot be expected to produce dramatic process improvements unless the personnel are adequately trained to use IT. Although this appears evident, many good redesigns have failed for lack of training. Additionally, IT needs to be maintained. Computer hardware requires repair and upgrading. New releases of software require installation. Databases and networks require administration. Indeed, software maintenance, for example, is known to consume roughly two-thirds of the total life cycle cost for software.

Table 3. Explanation of Diagnosis Given by KOPeR (Cont.). [Ref. 12]

Using those explanations from KOPeR, we go to the next step.

C. HOW TO IMPROVE THE PERSONNEL MANAGEMENT PROCESS

From hand off fractions, it is easily observed that the process must change the managerial organization. The friction produced in the system by the handout fraction must be reduced. In this case the lack of automation is one of the main causes of the amount of handouts. From feedback fractions, it is noted that feedback needs too much checking in a complex looping, which requires a change in this feedback process. IT support fraction looks appropriated inside some stations. The main problem is in the communications supported by IT, where the indicator shows inadequate IT communications. One of the first priorities of IT automation is substantial infrastructure in terms of support and communication.

Based on the KOPeR Pathology Diagnosis and Redesign Advice, the baseline A-diagram can be deduced in order to improve or redesign the

Personnel Management Process mainly for periodical reports and database information updates and for obtaining the following reduced A-diagram in Figure 3, where a smart card based system with network communications is applied.

This solution is only for one of the processes in the personnel Management System that allows for easily finding the diagnosis from before, but the implementation of the solution must be in the entire system. That is possible through the use of smart cards with applications in several fields at the same time. Smart cards give an automatic input to the network, reducing time and as a more consistent source of data to the system.

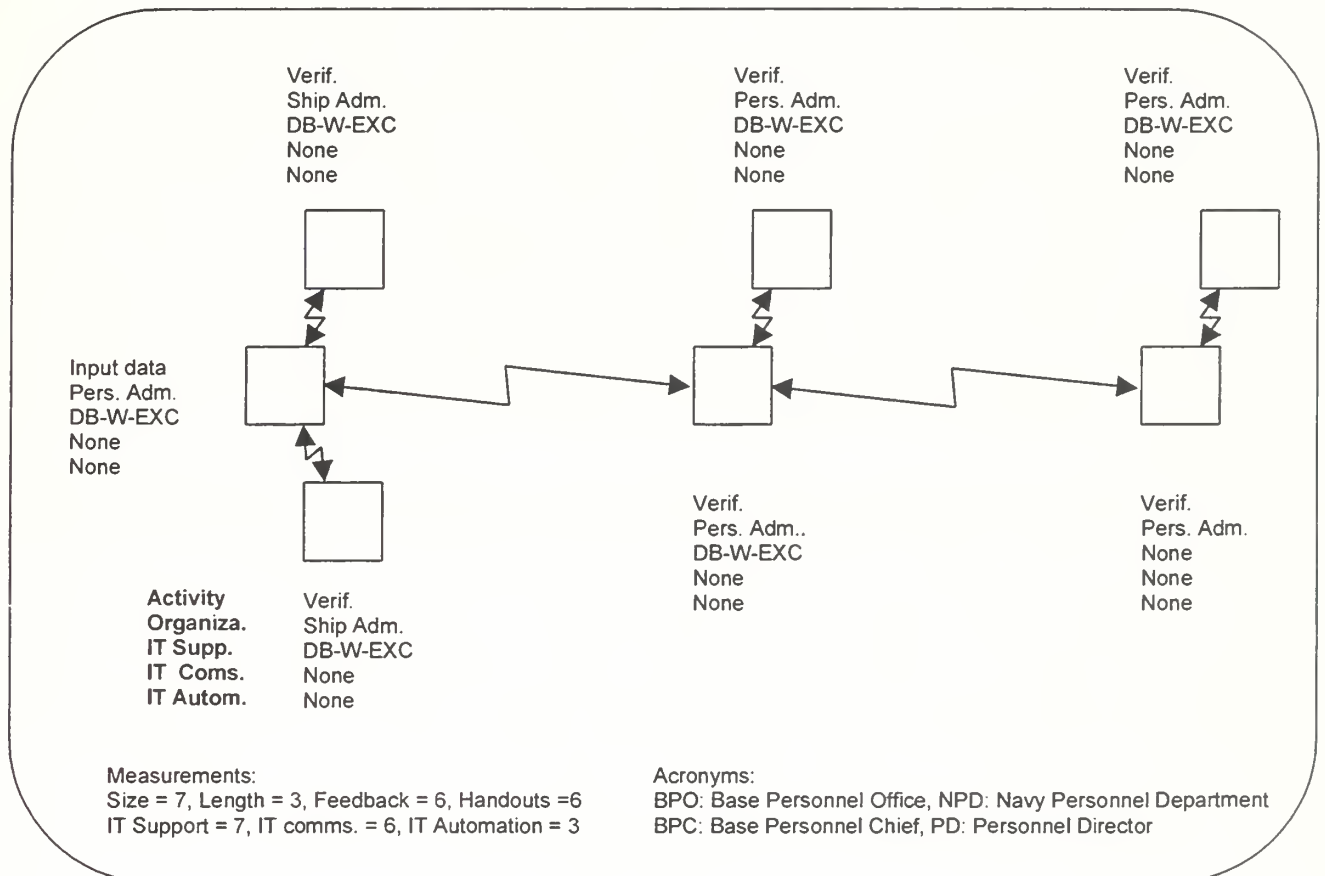


Figure 3. Simplified Redesigned A-diagram of the Personnel Management System in the Colombian Navy. For Periodical Reports and Database Information Update.

To assess the potential improvement associated with the redesigned process depicted Figure 3, KOPeR is applied to the letter, redesigned process measurements. The pathologies listed in Table 4 depict the state of this redesign process. One can see from the table that the process still suffers from pathologies, including process friction and feedback fraction, but has been improved dramatically:

Measurements (e.g., size of 7) suggest the small Personnel Management Process suffers from the following pathologies:

Parallelism (2.333) - parallelism looks OK for this class of process.

Handoffs fraction (0.857) - process friction.

Feedback fraction (0.857) - checking & complexity.

IT support fraction (1.0) - IT support looks OK.

IT communication fraction (0.857) - IT communication looks OK.

IT automation fraction (0.429) - IT automation looks OK.

Table 4. Pathologies of the New Process Identified by KOPeR. [Ref. 13]

Based on its pathologies, KOPeR recommends the changes listed in Table 5 be considered.

Recommendations:

For redesign, we recommend you consider the following:

Try a case manager or case team to decrease friction; be sure to include a source of expertise.

Try empowerment to reduce the amount of checking in the process; be sure to address training and incentives."

**Table 5. Recommendations of the New Process Identified by KOPeR.
[Ref. 13]**

These recommendations are applicable for this specific process since the personnel data and reports must be completed based on facts and statistical data that can be generated by computers and transferred between them. The role of people in the system is to verify that data is input on time and correctly. Since the data is reported automatically, special responsibility for the delivery to the XO and CO is not required. They do not need to waste time in checking and verifying this information. Only the personnel office must be aware that any change in personnel status needs to be input immediately into the system.

Thinking in a more integral solution for the Navy, it is also good to accept the recommendation of including a source of expertise in the system. In this case, this source of expertise must be a more efficient department of personnel per unit. This does not exist in particular on ships, and the administrative burden is on the CO's and XO's shoulders.

On the biggest ships, it is necessary to assign, as a source of expertise, a logistic LTJG or LT. as a Department Head of a Department that needs to have logistic and personnel functions. It can be called the "Personnel and Logistic Department." This helps in fixing two of the biggest problems in the

administration of these types of ships. The CO and the XO are responsible for the administrative system, since each year a recent graduate logistic ensign is assigned as the head of the Logistic Department. Since a problem in this area can damage the reputation and even be a cause for criminal prosecution, CO's and XO's, attend personally to these matters, which take a great deal of time that should be used to improve operational and general management issues on board the ship. Having an experienced LT as a Logistic and Personnel Department Head allows the CO and XO more time to think about the future of the ship, technological updates, look for resources, operational plans as a unit and in the fleet, training planning and directions, and improving what is already available on the ship.

It is important to keep in mind empowerment since the biggest change in the process is to consider a Logistic LT or a LTJG as a source of expertise onboard. This is a big change because the logistic officers' careers are designed for LTJG and above, and there is no obligation to return to ships. It will take a good program to make them think being onboard is a good choice. This can be done through technology, and is a good opportunity by giving them the chance to create a new department that is going to handle technological improvement, and develops skills not only in logistic matters, but also in personnel and computers issues.

IV. ANALYSIS AND IMPLEMENTATION OF SMART CARD BASED SYSTEMS FOR PERSONNEL MANAGEMENT

A. INTRODUCTION

As seen earlier, there is a lot of potential for Smart Cards to improve personnel management procedures. In order to simplify this study, some functions that are not normally done in the realm of personnel but are related to these procedures are looked at because personnel uses are involved.

There are several opportunities for using smart cards for personnel management by taking advantage of the multi-applications smart cards, which can accomplish different tasks with only one card. Each of these tasks can resolve a deficiency in the personnel management process, decrease the administrative burden of some navy members, improve or at least speeds up the process at a relative low cost by acquiring state-of-the-art technology in hardware and software, and create a new modern personnel administration process.

Smart cards can reduce the reliance on inefficient, uncoordinated, and obsolete databases and replace those databases with a portable one that can be instantly accessed at any location in the system. Another benefit is that it may eliminate redundant and time-consuming paperwork, reduce human error, the cost of information processing and duplication, and the wait in time consuming lines. There would also be less need to carry cash that translates into more convenience and security. [Ref. 6]

B. GENERAL OVERVIEW OF THE APPLICATION IN THE COLOMBIAN NAVY

Organizations must modify themselves not just from time to time, but all of the time. Large organizations must find ways to act like small organizations. [Ref. 9]

The use of the Smart Card in the Colombian Navy is necessary because of the amount and frequency that data is interchanged among the Navy Units. It is completely inefficient to re-enter that information each time, and the system is susceptible to incongruent information.

The main Navy base is already implementing a security system based on a non-contact card. It is only for security matters and makes the use of multi-application cards more urgent before a proliferation of different types of single use cards in the Navy. With Smart card applications, all personal data always remains on hand but stays private and confidential and only authorized persons can use.

With the Smart Card Based system, the solution in this thesis is going beyond traditional Personnel Management. However, it does not represent a significant additional cost to do so with the same smart card, but it is possible to exploit to the maximum its system management capabilities.

To exploit smart card opportunities, it is necessary to know its capabilities and personalize those capabilities to meet the needs of the Colombian Navy. The capabilities of the SC were described above. The analysis of those capabilities and the problems that personnel management encounters makes it possible to find the partial or total solution to those problems through the use of each of these capabilities, a combination of some capabilities or a modification of some of them.

1. Capabilities and Problems

a. Identification (ID)

A Smart Card (SC) reader would be installed at every unit front desk. On large bases it would directly communicate with the front desk computer.

(1) **Crew Arrival.** The SC will record when each member arrives to the unit, verify ID, and log the arrival time in the list for the day. The Navy can use this data for tracking any member depending on the way the management program is set up. The personnel officer and/or the officer on duty can use this function to verify which members are currently available in the unit. Warning notices can be included in case any member with a problem is coming into the unit or if a retired member has an old card and is trying to enter the unit.

(2) **Crew Departure.** The SC input information and the system automatically verifies if a member is on the authorized list for leaving, has any unit tool or weapon pending, or if there any requirement pending. Once authorized, the name is removed from the available personnel list.

(3) **Security.** The unit can also use ID features for security levels ID, different facilities' access, document's classification, radio stations and networks access. The information on the card is personal data and any code for special features such pending tools or security level. All other information is implemented via computers.

b. Health. Health issues have not always been considered a Personnel Management issue, but since the SC based system can be used in order to improve this service, and personnel are directly affected by it, the issue can be included as a personnel issue.

The main data storage of the naval medical service has to be located in the Naval Hospital in Cartagena. The next step in the system is the Bases' Clinics and lastly the ships and minor units.

The Naval Hospital has to have several readers with different levels of access. One reader must be located in emergency. Whoever takes the patient into the hospital can produce the card even if the patient is unconscious, and the computer will display all the essential medical information needed for an emergency. This information can include the clinic history number, blood type, allergies, immunization data, drug interactions, the unit assigned, emergency contact, and short notice alert about any important prevention such as high blood pressure problems or kidney failure.

One reader will be located in the general medical section. When the patient arrives, the SC is read and the information is transferred to the physician's computer where he has the appointment and/or the clinical history is given to the physician. At the consultation, any new relevant information is added to the SC such as if the patient needs to be hospitalized, if new allergies are discovered, or if there is a new health restriction. Prescriptions can be included in the SC, or can be sent by the computer to the pharmacy. The overall information that is communicated to the medical central is included in the system and as is the clinical history and the data in the system is updated for further use by other units. This information is confidential and each part of the system only has access to certain data, for example, the physician only to the medical data, the pharmacist to the prescription, etc.

One reader will be located at the specialists' front desk with the same functions and adds which general physician sent the patient. One reader will be located in the pharmacy for the ID function and/or for reading the prescription input by the physician and charging the drug to the inventory. This helps to more accurately control the drug. This data in the computer can then be used for statistical purposes and for inventory management such as an alert for low levels of stock in the computer to logistics.

If the internal laboratory is connected to the network, results could be electronically transmitted to a central location to be made available for medical staff review. Authorized personnel insert their SC in order to access information, and in the physician's office, the doctor's SC and/or the patient's must be inserted in order to access information.

c. *Wardrobe*

This is a very simple and useful function, as is any e-purse application. What the SC carries is the balance of money available in wardrobe assignation. In this way any Navy's wardrobe store can provide the garments that the member needs in any location in the country where a wardrobe store exists. The value can be deducted as soon as the garments are received and a new balance then appears on the SC.

d. *Records*

This is necessary when a Navy member is transferred. The essential information travels with him in an official way. Inserting the SC in the personnel office of the new unit, the SC sends a code that allows the member's file to be transferred to the unit. The unit can analyze the training and background of the new member in order to assign him the job that best fits his capabilities. The SC can show information about the date of the last complete evaluation, and any relevant data in the personnel records. The personal data is included automatically in the new unit's database that saves time, reduces human error and eliminates redundant and time-consuming paperwork.

C. MODEL PROTOTYPE IN A LIGHT FRIGATE SHIP CLASS ARC "ALMIRANTE PADILLA"

The first step in testing the implementation of a Smart card based system for personnel management in the Colombian Navy is to develop a model or prototype that permits, at a low cost in an ideal environment, a demonstration in practice of the benefits of such a system as an "effective defect prevention

technique.” [Ref. 14:pp. 14-23] The next step is to implement the system throughout the entire Navy.

Two units were considered in order to choose where to design the prototype. A Light Frigate (LF) ship “Almirante Padilla” class, and the Naval Academy “Almirante Padilla”(NAAP), both present the best characteristics in material and personnel to test the benefits of the system. LF ships were chosen mainly because of the size of the prototype, and the system needed is more personnel related than in the NAAP. The Naval Academy also offers a good environment in order to develop a Smart Card based management system larger than the personnel management system being discussed in this study.

Having chosen LF ships for the prototype, the main idea is to try to utilize the existing hardware as much as possible; assuming that all the existing computers are at least 486's and Office 95 compatible. All the existing computers are currently not networked together. They run independently operatively and administratively in the departments show in the graph in Figure 4.

The purpose of the model is to provide on board a Light Frigate (LF) Ship all the applications needed by the Navy to manage personnel administratively and operatively using a Multiple Application Smart Card system. The LF ships are the most modern ships in the Colombian Navy. LF ships are units that have upgraded their operations, weapons and engineering systems. The organization's commitment is guaranteed since the people involved are open-minded to new technology and procedures. Moreover, the logistic department is so far the only one not updated and is willing to be, and the personnel department does not even exist yet.

In order to develop the best solution for a ship, the problems described for the whole navy and the specific problems in a ship type unit will be considered.

It is normally said that personnel is the most important asset. While this only seems like something nice to say, but if the ship's organization is looked at, it really does not mean that at all. The structure in the organization is not conducive to personnel planning and maintenance. COs and XOs have to plan, order, execute and correct all personnel initiatives. Welfare is usually a second function for the most junior ensign onboard. Even though he receives feedback from the people onboard and it is monitored by the CO and the XO, it is nice to have tasks but they are not very serious or well planned manpower doctrine or policy.

In order to implement the prototype on board a Light Frigate (LF) ship it is necessary to organize the "Personnel and Logistic Department" on the ship. In addition to a LT or a LTJG, it is necessary to assign an enlisted person with computer skills to collaborate with the IT implementation and organizational matters.

The implementation of the operational capabilities of a SC based system that includes automatic updates of exercise lists, should have a new doctrine implemented for the organization of those exercises. COs, XOs and department heads must develop this doctrine after several tries to find the best way to take advantage of the system for the efficacy of the exercise conducted.

With the Smart Card Based system, the solution in this paper is going beyond Personnel Management, but does not represent any significant extra costs to do so, but exploits its system management capabilities.

The best way to understand the advantage of the Smart Card systems and the new capabilities that such a system is going to provide is to talk about applications. The Smart card applications discussed earlier but which are accommodated for the necessities of the ship are discussed below. The stations to be implemented on board the LF ship are described in the graph.

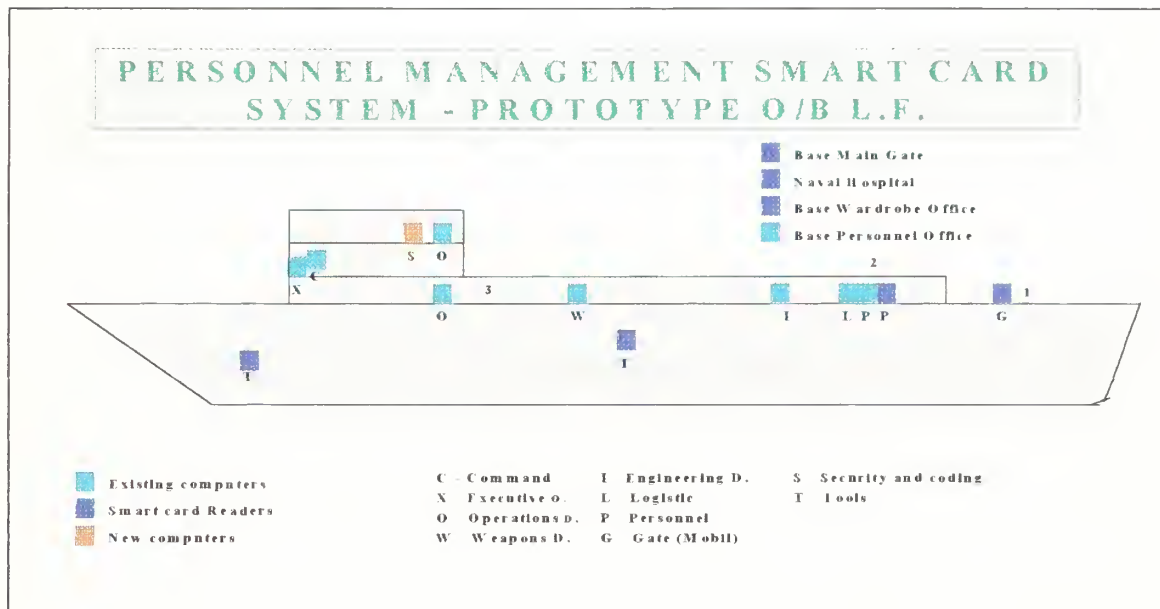


Figure 4. Stations Distributed Onboard LF Ships.

1. Smart Card Applications

a. Gate (Mobile)

A Smart Card (SC) reader would be installed at the front desk. This desk is mobile depending on the way the ship is connected to the pier. There are 6 possible points where it can be located: 1, 2, and 3, for each side of the ship.

(1) Crew Arrival

This point reads the SC of each crewmember upon arrival to the ship, verifies the ID, logs the arrival time in the list for the day, including the name on several lists on board for operational exercises. The name is automatically included on the list for lunch and/or dinner and breakfast, depending on the day and duty turn.

(2) Crew Departure

This point reads the SC and the system automatically verifies if the member is on the authorized list to leave, if any tool is pending, or any requirement is pending. After this, the return time is verified depending on

work for the next day or for duty on the weekends, or both. The system generates a message with the information for the officer on duty, who authorizes the leave after verifying the return time.

b. Personnel Office

This office has a computer where all the personnel information is stored. It is not connected to any computer on board or externally. It would be installed as a SC reader. It is the main station for inserting data of the personnel arriving for the first time to the unit or after any kind of recess. There would be only four people authorized to make any changes to the personnel database. These people are the XO, the Personnel Officer, the Master-at-Arms (a more senior enlisted, generally), and the Senior Corpsman. These people have to introduce their own SC to get authorization for making changes, and will register who did. The senior Corpsman would have access only to medical information, and input all changes to the initial database, and afterwards any changes about the health of any crewmember.

The LF personnel office sends reports periodically to the Base Personnel Office, weekly, monthly, quarterly, semiannually, and annually. In implementing this option, the forms of the reports would be sent. There would be about 10 different report forms with each one including about 90 people.

It would be necessary to connect this computer to all other stations inside the ship to each department (4). Each one would have access to their own people, and the CO and XO to the entire database.

c. CO (Commanding officer)

The XO would be able to communicate with all the computers on board, and have the ability to introduce a "Plan of the Day/Administrative Announcements" each day to be read by all the computers on board. This is not a smart card capability but a feature that the management program can have.

Only the CO and XO would be authorized to include information in the plan of the day or administrative announcements, for example, Deadlines for the day. They would have the ability to monitor the status of personnel on board on his screen at any moment, and include any requirement for personnel leaving the unit. They should have Intra-email service.

d. XO (Executive Officer)

The XO has complete administrative control of the ship, including managing the operative watchbills and the general training on board. Those watchbills are completed with the Department heads (DH) that provide the personnel for each one. The XO compiles the watchbills from the department heads conducted at a meeting, but each DH can send his own part of each watchbill with the system. The XO needs to have all the possible information on his computer. The main watchbills are: Combat (at sea and in port), Man overboard, Fire fighting (at sea and in port), Low visibility, Swept channel, Abandon Ship, hello launching and recovering, towing, personnel transference, replenishment at sea. Of these, the ones underlined would be the main ones to be automatically updated by the system. The system should have Intra email service. For training purposes it should have a form for daily exercises in port, and at the sea. A signal from the system can be sent to TVs that shows the updated watchbills for the exercises for Officers, Petty Officers and enlisted wardrooms, and the computer in CIC as well.

e. Department Heads (O, W, I, P&L)

Each one has access to his part of the watchbill for the ship, for example, the places that his personnel cover in combat. They should have access to the "Plan Of The Day/Administrative Announcements" screen. They should have Intra-email service. They can make submission by means of the internal personnel requirements to the XO. They can check the personnel status of his own personnel and of the duty turns. They should read the daily training schedule.

f. Security and Coding

This would be the only place where it is possible to conduct any change in the programs and it is the only place to assign levels of security to the SC holders in accordance with their own classification. The only personnel with SC authorization to make these changes are the CO, XO, Coding Officer and Systems Officer. This computer would be located in the Coding room which has special security measures.

g. Weapons and Tools

There would be one reader for weapons issuing, and two main spots for registering the tools given to the crewmembers for working on the ship. The SC readers send the information directly to the system and include this information in the files of the crewmember until he returns the tool(s). If the crewmember is going to leave, the unit at the front desk would prompt that he has a weapon or tool that needs to be returned before leaving.

h. Officer on Duty

Can have a portable wireless reader in his pocket in case any verification of the SC has to be done while he is not at the front desk.

Figure 4 also describes three **external** experimental stations.

2. External Experimental Stations

a. Base Main Gate

With a smart card reader, which is provisional for the test, the crew member shows his ID and it is verified. The Main Gate has a computer which is only used for ID processes.

b. *Naval Hospital*

It is located 200 meters from the Base Main Gate. Initially for the test, only one reader would be located in emergency or in general medicine, where the crew arrives with the SC and the doctor takes the patient's personal and essential medical information.

c. *Base Personnel Office*

The Personnel Office on the ship needs to be connected with this office. There are modems in this office, but not on board the LF. The LF personnel office sends reports periodically to this office either weekly, monthly, quarterly, semiannually, and annually. In order to implement this option, the of the report forms should be digitized in the system. They are about 10 different report forms.

d. *Wardrobe Store*

A reader would be installed in the Wardrobe store in the homeport of the LF ships for the model and testing of the system and further expansion. The crew of the LF using the same SC would be able to be connected to the e-purse application of the SC. When arriving at the store, they do not have to wait for cards files, but can sweep the SC card in the reader. When the garments are received, the balance is automatically updated in the SC. This function would train the LF's crew and the Store personnel, and test the system nationwide in the Navy. The system can be set so that the Personnel and Logistic Department Head has access to the balances in case crewmembers do not dress properly, and he suggest correct garments to acquire in order to have uniformity among the crew.

3. *Implementation*

The implementation of the prototype is broken down into three phases. The time for each phase would be flexible depending on the capability of the chosen company and the availability of the ship in port. Each phase will be

funded separately, facilitating the financing of the project, and the phase should be evaluated with a report prepared and submitted on the results and recommendations for further action.

a. Phase I

After approval from the Navy, order the system from a company. The company sends the requirements needs for the system to the ship and develops the software. The ship gets the equipment ready in the time while the company is developing the software and special hardware. The ship or the implementation team translates the screen presentations into Spanish. The hardware, cards, application license, translation and installation support by the company is included in Phase I.

b. Phase II

This phase is used for developing the specific reports and interfaces identified above, correcting any bug from Phase I and developing recommendations for additional applications.

c. Phase III

This phase is for the development of additional applications to have a fully smart card capable ship.

4. Selection by the Contractor Company

These phases do not include the Contractor Company's selection or the acquisition process. The starting point is the moment the Navy Staff authorizes the project. In order to made a correct selection the following points should be kept in mind.

- For systems like this it is better to use commercial off-the-shelf (COTS) products. It would be a waste of time and resources to try to invent something that is already or almost invented without any guarantee of success. Take advantage of more modern technology

that is compatible with the existing hardware onboard, which also was acquired as COTS products.

- In order to reduce risks, chose a company with experience in Multi-application Smart card systems, and if possible, in military or Navy environments.
- Select a contractor who has a defined set of standards for excellence in their product and process, and a proven track record of accomplishments for implementing these standards with documented results. Standards bring discipline to the process and a measurable quality to the product.
- The most crucial factor in the success of your program is to find the best company with the most talented software professionals who can do exceptional things. [Ref. 15: pp. 1-46]
- Verify that the company has a Software Development Plan (SDP) that defines the job including each major task. How will it be performed, what are the costs and schedule for the program, and organizational structure for performing the work, is there a framework for allocating the required resources, and a record of what was initially committed?. [Ref. 15: pp. 1-51]
- Organize a team to present united criteria in dealing with the Contractor Company following the program standards.
- Verify that the hardware and software involved in the program are able to support short run migrations with a warranty in the time planned.
- Develop an accurate test system that allows for verification of the system to ensure compliance of all standards beginning with the prototype. The experts on the team must test it to see if it is easy for the end users to use. Require program managers to stay with programs at least through the testing phase to maintain continuity and understanding of the original requirement nuances.
- Due to the dependency of the Personnel Management process created by the implementation of such a system, it is absolutely necessary that the Colombian Navy obtain a warranty for support, training and self-sufficiency in the use, re-programming, repairing and maintaining the system.

5. Hardware Needed

The following hardware is needed in the prototype implementation phase.

- 1 modem for the Main Computer of the Personnel Management System onboard.
- Intranet and connection among 9 computers on board
- 1 computer as the main computer for the SC system (S) (can be bought with an internal modem and avoids having to obtain the modem mentioned before).
- 6 Smart Card Readers
- 200 Smart Cards

6. Software Needed

The following software is needed in the prototype implementation phase:

Smart Card system management including the Intranet software (or Intranet separately, depending on the company's capabilities and cost-benefit analysis). Include the following features: Physical Access Monitoring, Personnel availability, Property Pass, Event and personnel Tracking, Medical, Project planning, Digitalization of forms described in each station, services as explained previously.

7. Support Needed

The following support is needed in the prototype implementation phase be it in a direct way or through step by step wizards.

- System Integration
- Training for two self-sufficient teams
- After sales support

8. Cost Estimates

A Smart Card system implemented for a ship, as described in the prototype, is valued at roughly \$60000.00, including hardware, software and support.

D. POST-PROTOTYPE IMPLEMENTATION NATIONAL NAVY WIDE

1. First Step

Once implemented, tested and corrected for possible bugs in the prototype, the next step is to implement the Smart Card Based System throughout the whole Navy nationwide. The more smart card ready units smart card available, the more efficient the whole system would be. The plan for implementing the system through the Navy must obey functional and geographical possibilities and constraints.

The logical path for the implementing of the following steps is described below.

2. Second Step

Copy the prototype into the other twin units. As a natural and logical step, further development of the system is not needed other than the correction of possible bugs found in the prototype. In order to accelerate and facilitate this step, personnel of the next twin ships must be trained and participate as much as possible in the prototype step.

3. Third Step

Design and implementation of other ships different from the LF ships in the Atlantic Naval Force.

4. Fourth Step

Design and implementation at the Cartagena's Navy Base and Naval Hospital of the personnel management system. Enlarging the infrastructure already implemented in support of the prototype, and analyzing the use of the Smart Card based system in other application base wide other than in the personnel system, as well as welfare facilities. This additional application is optional and would not deter the personnel management implementation in order

to reach the nationwide capabilities in the least time possible. This step covers all units that have their administrative headquarters at the Navy Base, as well as the Atlantic Naval Force Command, Surface Fleet Command, Naval Aviation Command and Submarine Fleet and School.

5. Fifth Step

Design and implementation at the Naval Academy “Almirante Padilla” (NAAP) in Cartagena. This step can be done simultaneously with the second or third steps depending on the availability of resources or the decision for using NAAP’s own resources in implementing the smart card based system. In addition to the Personnel Management System Navy wide, there are several other existing implementations in military academies that the Naval Academy can take advantage of. Such experience makes the Naval Academy a special place for easily implementing and efficiently improving the system. Smart card based systems have a wide range of automated services at military academies, not only in personnel issues, but also in educational environment. Another possibility is to implement a prototype for base systems, which can be smoothly different from the ship’s prototypes at the same time as the first step at the NAAP.

Several universities are using smart cards in a campus card system. The major uses of the smart cards are photo ID, meal plan, physical access to specialized rooms or laboratories, computer access, library book lending and control, prepaid phone services, prepaid cafeteria, laundry, copiers and stores services. [Ref. 15: p. 225] At the NAAP they can also be used for automatic bonus payments for cadets in the senior year, with no line, cadet’s leave controls, personnel availability controls, classes and events assistance control for cadets and teachers and behavior points.

The Smart card system has a proven application in the recruiting process in the US Navy with a wide range of improvements and a quickening of the recruiting process through stations controls that allow for fast procedures and

very good control and planning. In addition, deployment control capabilities can be used in the Naval Academy's implementation. The author can help in the development of such a system by implementing the best of the multi-application smart cards for most of the procedures at the Naval Academy.

6. Sixth Step

In the Sixth step the units in Cartagena have already implemented the system and are interconnected and any member can interact with any of these units with one smart card. In this step the Personnel Management System is migrated to the next level, connecting Cartagena's unit with the next steps in the chain the command in Bogotá. In this order of ideas, the Personnel Office in the Navy Base is connected with the Personnel Direction, and smart card readers and software are implemented in this direction. From this point on, Personnel Direction (PD) becomes the leading unit for the implementation of the smart card based personnel management system. At the same time, the Naval Hospital gets connected with the Navy Health Services HQ, and the Military Hospital, installing the necessary readers and software is able to connect to each other, and to give to smart card holders the same services as those as the Military Hospital.

7. Seventh Step

PD would implement the system in the entire Navy HQ and Bogotá units.

8. Eighth Step

PD will migrate this step to the other units of the Navy all around Colombia. Also, after testing the system and making the integration between the Navy Hospital and the military hospital, this step includes showing the benefits to the Army and Air Force Health Services, in order to implement an integrated system among the three forces and the Military Forces Command.

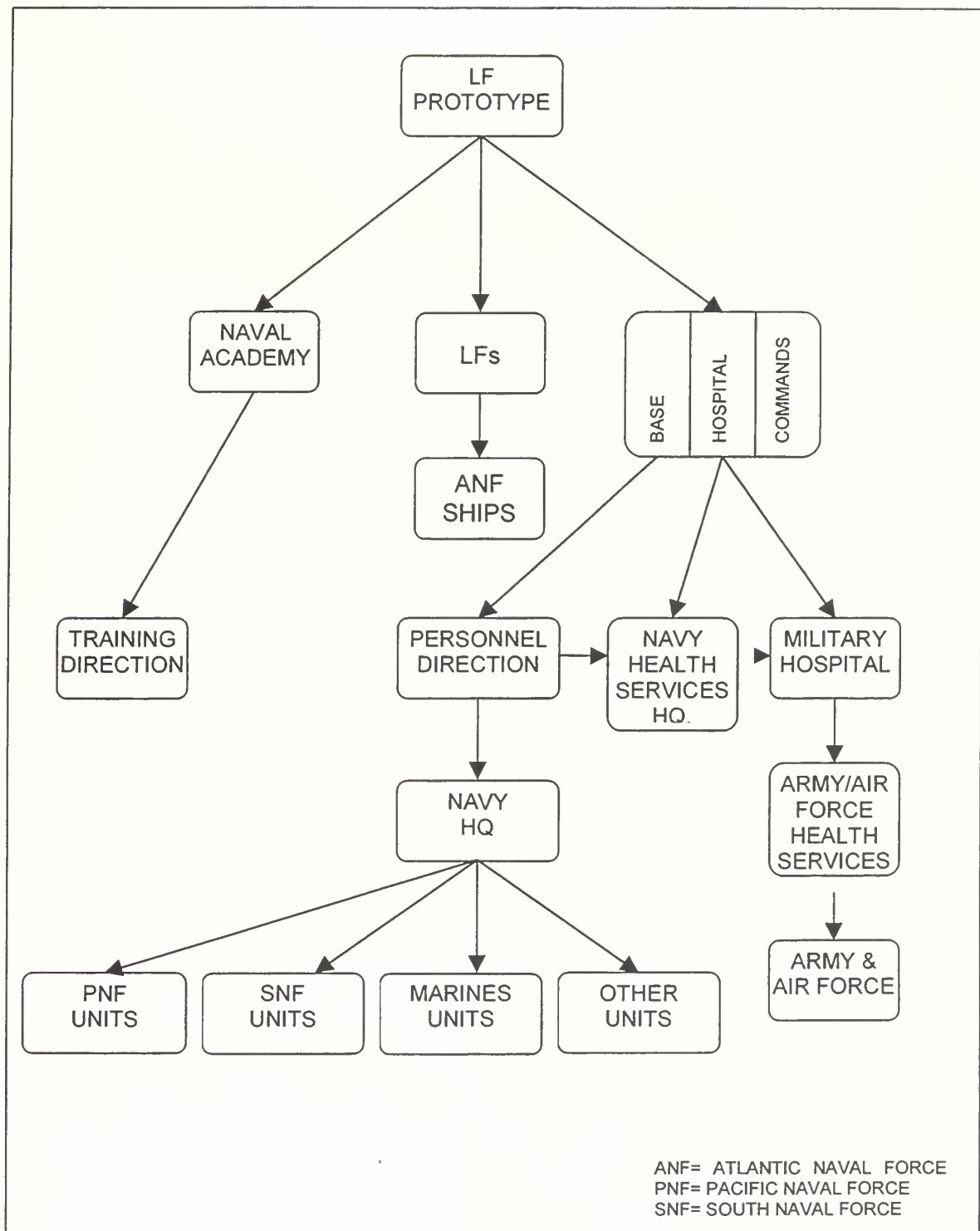


Figure 5. Navy Wide Implementation Flow Diagram

9. Ninth Step

Through the experience of other forces' health services integrated with the Military Hospital who have used the system first, the other forces will see the benefits and the entire system being used in the Navy as well. This step includes assistance to the Army and Air Force in the implementation of a Smart Card based Personnel Management System with previous authorization by these services.

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

1. In the Colombian Navy the Personnel Management Process works well more due to the excellent work capacity and commitment of the personnel in charge in the chain of command, than to good structure and technological resources. The inefficiencies in the Colombian Navy personnel process deserve the application of solutions in organizational and informational technology.
2. The Personnel Management Process is heavily burdened by relying on personnel outside the normal personnel system chain of command. This administrative burden creates inefficiency not only in the system, but also for important jobs such as Commanding Officers and XOs of ships and small units, and obligates them to reduce this efficiency in the pertinent tasks needed for job development.
3. The Smart Cards have state-of-the-art technology that can be used for improving the Personnel Management Process. At the same time, it alleviates a big administrative burden from important members of the Navy and thus gives them more time to plan and think more operationally.
4. Multi-application cards are very state-of-the-art technology in Smart Cards, and are the ones that the Navy needs to implement a Smart Card based Personnel Management System. This will give the Navy the opportunity to keep this leading edge in technology and create a better organization and more efficiency in administrative and operative matters.
5. Prototypes are an efficient way to test the benefits of the system, to test the applicability and acceptance in the environment and to analyze more accurately the needs for further application in the next step of a large organization and thus reduce risk. LF ships are the more suitable unit to be a prototype of such an automated system because of their background, the acceptance and easy adaptation of their crews to updated technology. The closed system in a relatively small unit allows for the implementation of the smart card system at maximum capacity in a short time. Smart cards are an enabling tool for Personnel Management performance improvement and the quality of life will improve for the Navy members.

B. RECOMMENDATIONS

1. The Colombian Navy has to maintain its leading edge in technology in the country. Since at this time, both the country and the Navy, are facing huge budgetary problems, the Navy has to look for economic ways to improve its technological situation in order to maintain this edge and to survive short term changes that the Military forces are soon going to be facing.
2. Create onboard the LF ships a "Personnel and Logistic Department," with a LT or LTJG as the Department Head. Included among its functions are personnel planning and control, personnel policy promulgation and welfare programs development.
3. Authorize the implementation of a Smart Card based system for improving the Personnel Management System in the Navy by beginning with the implementation of a prototype in a Light Frigate Ship which allows for the testing of the best system and an easy migration of this technology to the whole Navy.
4. Take advantage of the US Navy experience, especially in choosing companies that have experience, as a guarantee for success, and compatibility with the US Navy, and GSA department applications for future integration and compatibility.
5. Take advantage of the capability of the modular implementation of the system. The program could be financed by unit by assigning a budget to each unit or authorizing units to spend part of their current budget for this implementation. Avoid giving the Navy a very big budget for this project. The Navy would do better to acquire elements as the smart cards itself since the amount purchased has a big impact on the unit price.

C. AREAS FOR FURTHER RESEARCH

Since the Smart card industry is developing very fast, and more applications are released each day, and depending on the time necessary for the authorization process to occur, it will be necessary to update the technological needs of the system. Also, finding out if more applications are available would make the multi-application smart card system more useful.

From the advances made in this technology, research into an interaction between smart card systems and artificial intelligence or Automated Information Systems (AIS) should be conducted in order to find more efficient processes. This would then allow the top levels in organizations to spend their time on operational goals rather than on the administrative burden.

Taking advantage of the potential of biometrics in security and control smart card based systems, research in this field, technically and for management applications, should be interesting for the military forces.

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